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16 June 1981

East Europe Report

SCIENTIFIC AFFAIRS

(FOUO 7/81)

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PARAMETRIZATION OF THE OCEAN ACTIVE LAYER STRUCTURE IN THE MODELS OF LARGE-SCALE ATMOSPHERIC PROCESSES

Sofia KHIDROLOGIYA I METEOROLOGIYA in Bulgarian No 1, Jan 81 pp 3-12

[Article in Russian by D. L. Laykhtman and G. I. Korchev]

[Text] Introduction

The creation of numerical models of large-scale atmospheric circulation is one of the most important achievements of dynamic meteorology in the past 30 years. From an applications point of view, they may be divided into two basic groups:

1. models for detailed calculation of the temporal evolution of large-scale circulation according to an observable initial state. Standard operative weather forecasts performed by weather services in many countries are now based on just such models;

2. models for climate description and prediction. The accuracy of the representation of the initial state, being of primary significance in weather prediction, is not so significant here.

Representation of the boundary conditions and parametrization of the interaction of the atmosphere with the spreading surface is of decisive significance when constructing models of both groups.

Numerical experiments [6] show that the accuracy of weather prediction over a protracted period and the adequacy of climatic calculations increases noticeably if the variability in the temperature of the ocean's surface is taken into consideration, and it is inconceivable to do this without drawing upon a model of the upper layer of the ocean which makes prediction of the water temperature possible.

The development of a model for a quasihomogeneous layer of the ocean describing the structure and the temporal variability of its thermal and dynamic characteristics and their connection with meteorological parameters is the primary goal of this work. This type of solution to the problem being examined provides a concrete physical basis for taking the ocean's role in the evolution of large-scale atmospheric processes into consideration.

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Mathematical Model of a Quasihomogeneous Ocean Layer

The task is examined in a rectangular left-hand coordinate system with zero at the ocean surface. The x-axis extends to the east, the y-axis to the north and the ζ-axis the depth of the ocean.

A nonlinear univariate nonstationary model of a quasihomogeneous ocean layer is constructed.

The following hydrothermodynamic equations for a turbulent fluid are taken as the initial data:

motion

$$(1) \qquad \frac{\partial \tilde{u}}{\partial t} = \frac{\partial}{\partial \zeta} \tilde{k} \frac{\partial \tilde{u}}{\partial \zeta} + f \tilde{v},$$

$$(2) \qquad \frac{\partial \tilde{v}}{\partial t} = \frac{\partial}{\partial \zeta} \tilde{k} \frac{\partial \tilde{v}}{\partial \zeta} - f \tilde{u},$$

heat influx

$$(3) \qquad \frac{\partial T}{\partial t} = \frac{\partial}{\partial \zeta} \tilde{k}_T \frac{\partial T}{\partial \zeta},$$

salt diffusion

$$(4) \qquad \frac{\partial S}{\partial t} = \frac{\partial}{\partial \zeta} \tilde{k}_s \frac{\partial S}{\partial \zeta},$$

turbulence energy balance

$$(5) \qquad \tilde{k} \left[\left(\frac{\partial \tilde{u}}{\partial \zeta} \right)^2 + \left(\frac{\partial \tilde{v}}{\partial \zeta} \right)^2 \right] - \frac{g}{\tilde{\varrho}_0} \tilde{k}_\varrho \frac{\partial \tilde{\varrho}}{\partial \zeta} + Diff - Diss = 0,$$

state of the sea water

$$(6) \qquad \tilde{\varrho} = \tilde{\varrho}(T, S, p),$$

where t - time; $\tilde{u}$, $\tilde{v}$ - current velocity components along the x- and y-axes; T,S and $\tilde{\varrho}$ are, respectively, temperature, salinity and density of the sea water; k, k , k_T, k_S - coefficients of turbulent viscosity, diffusion, temperature conductivity and salt diffusion; $f = 2\omega_0 \sin\varphi$ - the Coriolis parameter; ω_0- angular velocity of the earth's rotation; φ - geographic latitutde; g - gravitational acceleration; $g/\tilde{\varrho}_0$ - bouyancy parameter; $\tilde{\varrho}_0$- average value of density in the ocean; Diff and Diss are, respectively, diffusion and dissipation of turbulent energy.

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Let us note that in the initial equation system, advection, horizontal diffusion and large-scale vertical movement within the ocean are not taken into consideration. The currents are assumed to be purely of wind origin, i.e. drift currents. Absorption of short wave radiation occurs at the ocean surface.

As applicable to the task under examination (prediction for the atmosphere), it is adequately correct to express the integral influence of the ocean on the atmosphere. Therefore a means for schematicizing its vertical structure is fully justified. However, the integral effects should not be distorted in doing so. Profiles of currents, temperature and salinity are approximated by the following formulae:

$$\tilde{u}+i\tilde{v}=(\tilde{u}_0+i\tilde{v}_0)\,e^{-\frac{\alpha(1+i)\zeta}{h}}, \tag{7}$$

$$T(\zeta)=T_0-[T_0-T_h+\Gamma_T(\zeta-h)]\,\varepsilon\left\{\frac{\zeta}{h}-1\right\}, \tag{8}$$

$$S(\zeta)=S_0-[S_0-S_h+\Gamma_s(\zeta-h)]\,\varepsilon\left\{\frac{\zeta}{h}-1\right\}. \tag{9}$$

Here the following designations are adopted: T_0, S_0 -temperature and salinity of the quasihomogeneous layer; T_h, S_h - temperature and salinity at $\zeta = h$; $i^2 = -1$; h - thickness of the quasihomogeneous layer; Γ_T, Γ_S - gradients of temperature and salinity in the seasonal thermocline below the layer of discontinuity.

$$-\frac{\partial T}{\partial \zeta}\bigg|_{\zeta\geq h}=\Gamma_T=\text{const}>0; \quad -\frac{\partial S}{\partial \zeta}\bigg|_{\zeta\geq h}=\Gamma_s=\text{const}<0; \tag{10}$$

$\varepsilon\left\{\frac{\zeta}{h}-1\right\}$ — Heaviside function

$$\varepsilon\left\{\frac{\zeta}{h}-1\right\}=\begin{cases}0 & \text{at} \quad \zeta<h,\\ 1 & \text{at} \quad \zeta\geq h.\end{cases}$$

As may be seen from (7), the profile of the currents is assumed to be similar to the "(Eckman)." The dimensionless parameter α is found from empirical data so that formula (7) describes the integral influence of the layer under examination on the atmosphere in the best way possible.

Formulae (8) and (9) reflect the specific nature of the active layer of the ocean: the constancy of T and S within the quasihomogeneous layer (0, h), the jump in temperature $\Delta T = T_0 - T_h$ and in salinity $\Delta S = S_0 - S_h$ on $\zeta = h$ and the corresponding monotone movement with depth of the values of the very same elements within a seasonal thermocline.

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The equation for the state (6) is used in Lineykin's form

$$(11) \qquad \tilde{\varrho}=\tilde{\varrho}_0(1-\alpha^* T+\beta S),$$

where $\alpha^* = 2.10^{-4}{}^\circ C^{-1}$ - coefficient of thermal expansion;

$\beta = 8.10^{-4} ppm^{-1}$ - an analogeous coefficient for salinity.

Integrating the equations for motion (1, 2), heat influx (3), salt diffusion (4) and turbulence energy balance (5) throughout the entire quasihomogeneous layer from 0 to h + 0 using the parametric profiles (7-9) and the equation for state (11) we obtain

$$(12) \qquad \frac{\partial \tilde{u}_0}{\partial t}=-\frac{1}{h}\left[\tilde{u}_0\frac{\partial h}{\partial t}-fh\tilde{v}_0-\frac{a}{\tilde{\varrho}}(\tilde{\tau}_{x0}-\tilde{\tau}_{y0})\right],$$

$$(13) \qquad \frac{\partial \tilde{v}_0}{\partial t}=-\frac{1}{h}\left[\tilde{v}_0\frac{\partial h}{\partial t}+fh\tilde{u}_0-\frac{a}{\tilde{\varrho}}(\tilde{\tau}_{x0}+\tilde{\tau}_{y0})\right],$$

$$(14) \qquad \frac{\partial T_0}{\partial t}=-\frac{1}{h}\left[\Delta T\frac{\partial h}{\partial t}-(\widehat{P}^T_0-\widehat{P}^T_h)\right],$$

$$(15) \qquad \frac{\partial S_0}{\partial t}=-\frac{1}{h}\left[\Delta S\frac{\partial h}{\partial t}-(\widehat{P}^s_0-\widehat{P}^s_h)\right],$$

$$(16) \qquad \frac{1}{\tilde{\varrho}}(\tilde{u}_0\,\tilde{\tau}_{x0}+\tilde{v}_0\,\tau_{y0})-\frac{h}{2a}\left(\tilde{u}_0\frac{\partial\tilde{u}_0}{\partial t}+\tilde{v}_0\frac{\partial\tilde{v}_0}{\partial t}\right)-\frac{1}{4a}(\tilde{u}_0^2+\tilde{v}_0^2)\frac{\partial h}{\partial t}$$
$$+\alpha^* g\left(\frac{h^2}{2}\frac{\partial T_0}{\partial t}-h\widehat{P}^T_0\right)-\beta g\left(\frac{h^2}{2}\frac{\partial S_0}{\partial t}-h\widehat{P}^s_0\right)-c\widehat{U}^3=0.$$

Here $\widehat{P}^T_0, \widehat{P}^T_h, \widehat{P}^s_0, \widehat{P}^s_h$ - turbulent flows of heat and salt on the upper and lower boundaries of the quasihomogeneous layer which have been normed for $\tilde{\varrho}\,\tilde{c}_p$ and $\tilde{\varrho}$, respectively; $\tilde{\tau}_{x0}, \tilde{\tau}_{y0}$ - tangential stresses on the ocean's surface.

The following simplifications and assumptions were made in deriving equations (12-16): generation of turbulent energy coming from the breaking of wind-driven waves is not taken into consideration; integral dissipation = $c\widetilde{U}_*^3$ (from an analysis of dimensionalities), where c - an empirical constant subject to determination and $\widehat{U}_* = \left[\left(\frac{\tilde{\tau}_{x0}}{\tilde{\varrho}}\right)^2+\left(\frac{\tau_{y0}}{\tilde{\varrho}}\right)^2\right]^{1/2}$ - velocity of friction in the ocean;

$$e^{-a}\ll 1;\ (\tau_{x0}+i\tilde{\tau}_{y0})\gg(\tilde{\tau}_x+i\tilde{\tau}_y)\Big|_{z=h}.$$

The system of integral relationships (12-16) which is obtained is a closed system of nonlinear ordinary first degree differential equations and it permits all sought values of $\tilde{u}_0(t)$, $\tilde{v}_0(t)$, $T_0(t)$, $S_0(t)$ and h(t) to be determined at the given initial and limiting conditions, which are evaluated in detail below.

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A simple conversion of system (12-16) results in a form which is more convenient for numerical realization:

$$\frac{\partial \tilde{u}_0}{\partial t} = -\frac{1}{h}\left[\tilde{u}_0 \frac{A}{B} - fh\tilde{v}_0 - \frac{a}{\tilde{\varrho}}(\tilde{\tau}_{x0} - \tilde{\tau}_{y0})\right], \tag{17}$$

$$\frac{\partial \tilde{v}_0}{\partial t} = -\frac{1}{h}\left[\tilde{v}_0 \frac{A}{B} + fh\tilde{u}_0 - \frac{a}{\tilde{\varrho}}(\tau_{x0} + \tilde{\tau}_{y0})\right], \tag{18}$$

$$\frac{\partial T_0}{\partial t} = -\frac{1}{h}\left[\Delta T \frac{A}{B} - (\widehat{P}_0^T - \widehat{P}_h^T)\right], \tag{19}$$

$$\frac{\partial S_0}{\partial t} = -\frac{1}{h}\left[\Delta S \frac{A}{B} - (\widehat{P}_0^s - \widehat{P}_h^s)\right], \tag{20}$$

$$\frac{\partial h}{\partial t} = \frac{A}{B}, \tag{21}$$

(22) where
$$A = \frac{1}{2\tilde{\varrho}}\left[\tilde{u}_0(\tilde{\tau}_{x0} + \tilde{\tau}_{y0}) - \tilde{v}_0(\tilde{\tau}_{x0} - \tilde{\tau}_{y0})\right] - \frac{gh}{2}\left[a^*(\widehat{P}_0^T + \widehat{P}_h^T) - \beta(\widehat{P}_0^s + P_h^s)\right] - c\tilde{U}^3,$$

$$B = \frac{gh}{2}(a^* \Delta T - \beta \Delta S) - \frac{1}{4a}(\tilde{u}_0^2 + \tilde{v}_0^2). \tag{23}$$

The temperature T_h and salinity S_h at the lower boundary of the quasihomogeneous layer are easily found using the following relationships:

$$T_h = T^* - \Gamma_T h, \quad S_h = S^* - \Gamma_s h, \tag{24}$$

(25) where $T^* = T_H + \Gamma_T H$, $S^* = S_H + \Gamma_s H$, H - depth of the active ocean layer. T_H and S_H - temperature and salinity, respectively at $\zeta = H$.

Thus the system of equations (17-21) permits us to determine the temporal evolution of the characteristics of a quasihomogeneous ocean layer given assigned <u>external</u> <u>parameters</u>:

$$\tilde{\tau}_{x0},\ \tilde{\tau}_{y0},\ \widehat{P}_0^T,\ \widehat{P}_h^T,\ \widehat{P}_0^s,\ \widehat{P}_h^s,\ \Gamma_T,\ \Gamma_s,\ T^* \text{ и } S^*. \tag{26}$$

Initial and Boundary Conditions of the Problem

I n i t i a l c o n d i t i o n s. Values for the function being sought are assigned at a certain instant $t = t_0$, from which numerical integration of the equations begins.

$$t = t_0,\ u_0(t_0) = \tilde{u}_0^н,\ \tilde{v}_0(t_0) = v_0^н,\ T_0(t_0) = T_0^н,\ S_0(t_0) = S_0^н,\ h(t_0) = h^н. \tag{27}$$

B o u n d a r y c o n d i t i o n s. The quantities of movement at the boundary of the water-air interface are reduced to the continuity of the currents and to determination of turbulent flows P_0^T and P_0^S from the equation for the balance of heat and salt of the sea surface:

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(28) $\tilde{\tau}_{x0} = -\tilde{\varrho}\,\tilde{k}\,\frac{\partial \tilde{u}}{\partial \zeta}\Big|_{\zeta=0} = \varrho\,k\,\frac{\partial u}{\partial z}\Big|_{z=0} = \tau_{x0},$*

(29) $\tilde{\tau}_{y0} = -\tilde{\varrho}\,\tilde{k}\,\frac{\partial \tilde{v}}{\partial \zeta}\Big|_{\zeta=0} = \varrho k\,\frac{\partial v}{\partial z}\Big|_{z=0} = \tau_{y0},$*

(30) $\tilde{P}_0^T = I_0 - E_{ef} - P_0^T - LE_0,$

(31) $\tilde{P}_0^s = \hat{\varrho}\,S_0\,(B - R),$

Here the following are used: u, v - wind velocity components; ϱ - air density; I_0 - flow of short wave solar radiation; E_{ef} - effective irradiation of the sea surface; P_0^T - vertical turbulent heat flow in the atmosphere; LE_0 - heat losses to evaporation; B - evaporation; R - rainfall.

For the tangental stress $\vec{\tau}_0 = (\tau_{x0}, \tau_{y0})$ in the layer of the atmosphere near the water, the following relationship gives good results in practice

(32) $(\vec{\tau}_0) = \varrho\,c_v\,(\vec{c}_0)^2,$

where C_v - coefficient of resistance and $\vec{C}_0 = (u_0, v_0)$ - wind velocity vector.

For the temperate and middle latitudes, the seasonal course of the total heat influx into the ocean $\tilde{P}_0^T$ is well approximated by the equation

(33) $\tilde{P}_0^T = -\tilde{P}_0^T \max \cos\left(2\pi \frac{t}{t_{yr}}\right).$

Here $\tilde{P}_{0max}^T$ - half range of the annual fluctuations of $\tilde{P}_0^T$ (taken from experimental data), t_{yr} = 365 days.

For determination of the turbulent flow of salt $\tilde{P}_0^S$, the annual course of the difference (B - R) is satisfactorily described by the formula

(34) $B - R = n - m \sin\left(\pi \frac{t}{t_{yr}}\right).$

If n = m for the winter months, B - R > 0, i.e. evaporation is the dominant process as compared with precipitation; for the summer B - R = 0, or evaporation compensates for precipitation.

If n > m during the course of the entire year, B - R > 0.

If n < m, in the wintertime, B - R > 0; for the summer B - R < 0, i.e. precipitation dominates.

* In both media, the tangental stresses are taken to be positive if they are directed downward.

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The turbulent heat flow $\tilde{P}_h^T$ and salt flow $\tilde{P}_h^S$ at the lower boundary of the quasi-homogeneous layer are usually taken to be as follows: equal to 0 (there are no currents); they make up a certain portion of the corresponding currents on the upper boundary proportional to $\Delta T \frac{\partial h}{\partial t}$ and $\Delta S \frac{\partial h}{\partial t}$.

Certain Physically Grounded Simplifications

1. The equations of motion are examined in quasistationary approximation.

During parametric calculation, the ocean's effect in models of large-scale atmospheric circulation, it is possible to examine the dynamics of the lower layer in quasistationary approximation.

2. The effect of salinity on stratification of density is not taken into consideration.

In the open ocean, vertical distribution of water density (the chief characteristic influencing the turbulent conditions) is primarily determined by its temperature. It is just in individual regions where intensive evaporation or abundant rainfall occur that the salinity of the sea water may significantly effect the vertical distribution of density.

The system of equations (17-21) for calculation of the temporal variability of the characteristics of a quasihomogeneous layer may be greatly simplified, taking on the following form:

(35) $$\tilde{u}_0 = \frac{a}{\tilde{\varrho} f h}(\tilde{\tau}_{x0} + \tilde{\tau}_{y0}),$$

(36) $$\tilde{v}_0 = -\frac{a}{\tilde{\varrho} f h}(\tilde{\tau}_{x0} - \tilde{\tau}_{y0}),$$

(37) $$\frac{\partial T_0}{\partial t} = -\frac{1}{h}\left[\Delta T \frac{A_1}{B_1} - (\hat{P}_0^T - P_h^T)\right],$$

(38) $$\frac{\partial h}{\partial t} = \frac{A_1}{B_1},$$

(39) where $$A_1 = \frac{a(\tilde{\tau}_{x0}^2 + \tilde{\tau}_{y0}^2)}{\tilde{\varrho}^2 f h} - \frac{gha}{2}(\hat{P}_0^T + \hat{P}_h^T) - c\tilde{U}_*^3$$

(40) $$B_1 = \frac{gha^*}{2}\Delta T.$$

The system of equations (35-38) was solved numerically. At first the thickness h and temperature T_0 of the quasihomogeneous layer is calculated using the (Renge-Kutt) method of fourth order accuracy. At each step values of h are introduced into equations (35, 36) to determine the components of the velocity of the drift current on the ocean's surface. A calculation was made with a constant 1-hour increment in time which was experimentally selected.

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Beside the values of the sought functions $\tilde{u}_0, \tilde{v}_0, T_0$ and h, at each step the components of the turbulent energy balance equation, the temperature jump and the average velocity of the drift current in the quasihomogeneous layer were calculated.

Numerical Experiments for Calculation of Seasonal Course of Characteristics of Quasihomogeneous Layer and Testing the Model According to Materials from Weather Station "Papa"

A series of special numerical experiments were performed based on model (35, 38) with the aim of studying the nature of the influence of various physical factors on the evolution of soughtafter characteristics in time.

Heat flow toward the ocean was given according to (33). The wind velocity was taken as constant during the entire year.

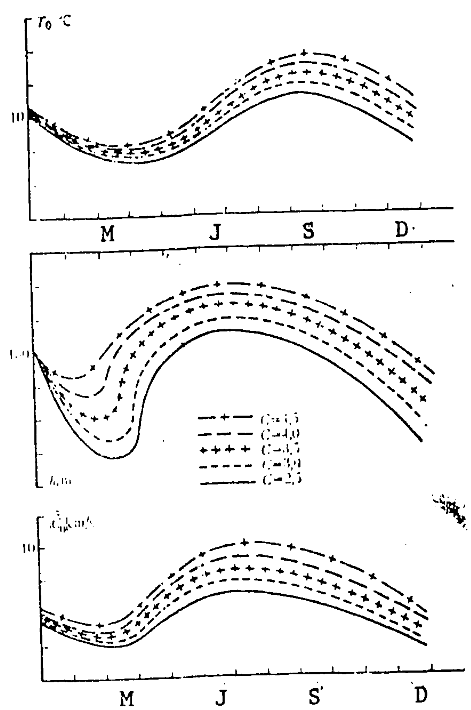

Figure 1. Seasonal Course of Characteristics of a Quasi-Homogeneous Layer Given Various Values of the Dissipati)n Coefficient C

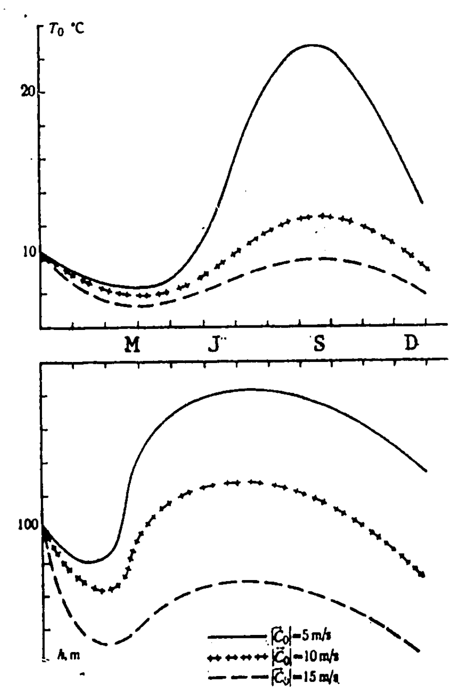

Figure 2. Results of Calculating the Seasonal Course of Temperature and Quasi-homogeneous Layer Thickness h Given Diverse Wind Velocity Values in the Layer Near the Water

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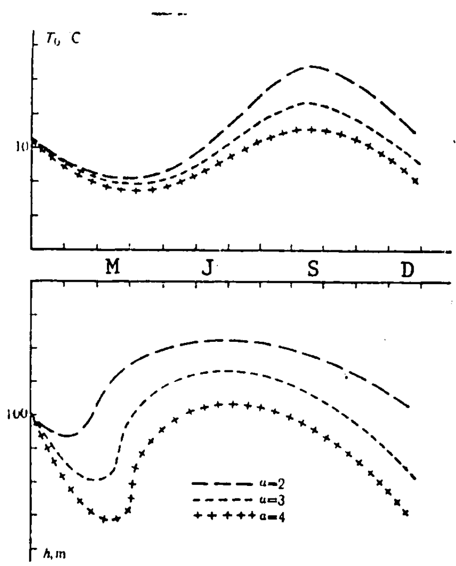

Figure 3. Seasonal Course of Temperature and Quasihomogeneous Layer Thickness Given Various Values of Coefficient α

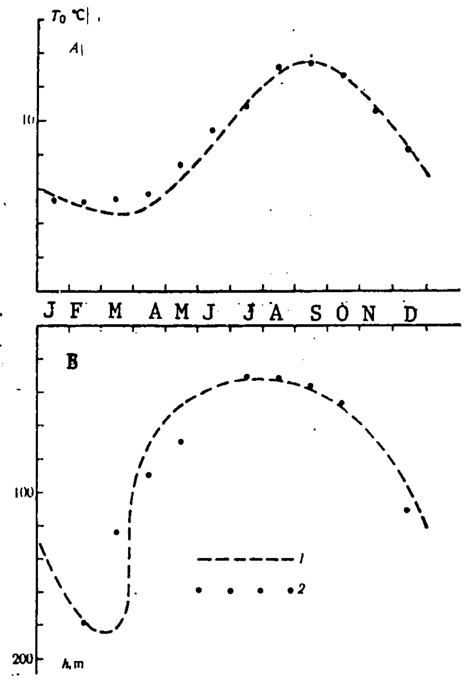

Figure 4. Seasonal Course of Temperature A and Quasihomogeneous Layer Thickness B
1-calculated based on the model;
2-according to data from weather station "Papa"

The results of the numerical experiments showed the following:

1. The best agreement with full-scale data [3], [5] is obtained when calculating the turbulent heat flow from the lower boundary of the quasihomogeneous layer according to the formula

$$\tilde{P}_h^T = \begin{cases} -\tilde{\varrho}\,\tilde{c}_p \Delta T \frac{\partial h}{\partial t} & \text{where } \frac{\partial h}{\partial t} < 0, \\ 0 & \text{where } \frac{\partial h}{\partial t} \geq 0. \end{cases} \quad (41)$$

2. The thickness of the quasihomogeneous layer diminishes and its temperature increases with an increase in the dissipation coefficient C (Figure 1).

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3. When c increases, the characteristics of the quasihomogeneous layer emerge into a periodic regimen more quickly.

4. The thickness of the quasihomogeneous layer increases with an increase in wind velocity and, naturally, the temperature of the ocean surface decreases (Figure 2).

5. Analogous wind changes are observed upon variation of parameter (Figure 3).

6. Increasing the amplitude of the total heat flow toward the ocean results in an increase in the amplitude of seasonal changes of the quasihomogeneous layer's characteristics.

Results of a test of the model based on materials from weather station "Papa" located in the northeast part of the Pacific Ocean (55°N, 145°W) are given in Figure 4.

The dependence (33), in which the value 350 cal cm^{-2} day^{-1} was selected for $P_0^T max$ on the basis of experimental data [1], was used to calculate the seasonal course P_0^T. According to Kil'matov and Protasov [4], the seasonal course of wind velocity in the region of station "P" is well approximated by equation

$$(42) \qquad |\vec{c}_0| = 11 - 5\sin\left(\frac{6}{7}\pi\frac{t}{t_{yr}}\right).$$

The values for the remaining input parameters are as follows:

$\alpha = 3$; $\Gamma_T = 0{,}03$ °C $м^{-1}$; $c = 3{,}6$.

Basic Conclusions

1. The integral relationships obtained from equations for the hydrotherodynamics of turbulent fluid are suitable for parametrization of the integral effect of the ocean on the atmosphere.

2. Calculation of the annual variability of temperature and thickness of the quasihomogeneous layer on the basis of the integral relationships obtained based on given atmospheric parameters agree well with experimental data.

3. Parametrization of the vertical profile of the drift current velocity produces reduced values on the ocean surface, however, it correctly reflects the magnitude of the average vertical shift in the upper layer of the ocean. This is not a significant shortcoming, and it does not effect the total circulation of the atmosphere inasmuch as the drift current velocity is negligibly small in comparison with atmospheric currents.

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CZECHOSLOVAKIA

TRENDS IN CSSR COMPUTER DEVELOPMENTS 1981-1985

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[Text] Data-processing equipment and automated management systems [AMS] achieved further progress and expansion in Czechoslovakia during the Sixth Five-Year Plan. By the end of the Sixth Five-Year Plan, a total of about 1,400 digital computers had been installed in our country for use in AMS and for performance of calculations and routine work. By 1980, about 280 control computers will be operating in manufacturing processes in this country, in addition to which about 600 minicomputers will be available for various purposes such as data collection and transmission and scientific and technical calculations. This equipment represents a total value of about Kcs 17 billion of long-term assets. Obviously questions of efficient utilization of this equipment, its further expansion and modernization and its configuration for AMS at various levels are gaining extremely high priority.

We have made further progress in AMS development at the enterprise level both quantitatively--in the number of systems constructed--and in design. At the intermediate management level, where organizational changes in the management system are taking place, the construction of AMS got under way during the Sixth Five-Year Plan. In the central organizations, primarily AMS with sectorial applications have been developed. The AMS of the central regional planning organizations have hitherto been designed primarily to provide automation for these organizations' own activities. Thus far there has been minimal success in introducing automation as a part of procedural management in regional planning activities, which affect practically all offices and organizations and are a precondition for integration of information and management systems.

Some ministries have proceeded to link together automated systems along the management chain from the central office through the VHJ's to the enterprises. Horizontal integration has thus far been undertaken only in isolated cases. A beginning is gradually being made in introducing such integration tools as a system of uniform classifiers and numerations.

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The pace of development of automated systems for control of manufacturing processes has thus far not fully met the needs of the national economy's development, in spite of the fact that the use of automation in such activities affords great savings of raw materials, energy and manpower. This state of affairs is influenced primarily by the shortage of design capacities and of suitable control computers and reliable automation components such as sensors, regulators and the like.

More than 40 percent of the 1,400 digital computers mentioned above belong to the JSEP series [Unified Series of Electronic Computers], while almost 23 percent of the others are Czechoslovak-produced and more than 17 percent are imported from socialist countries. The computers' capabilities will be used not only in AMS but also for the performance of individual calculations and for routine work.

About 50,000 persons work in the AMS field in computer centers, including about 15,000 in programming and planning and about 45,000 in computer center operations; about 20 percent of the latter group are operators of data acquisition and collection equipment, 16 percent are operators of computers and other data-processing machinery, and 11 percent are input-output control personnel. In addition to these workers, about 20,000 workers in offices and organizations outside computer centers and about 5,000 workers in the scientific research base will participate directly in the preparation of AMS.

During the Seventh Five-Year Plan, the development of the Czechoslovak economy will proceed under conditions in which important increases in manpower cannot be expected, the fuel and energy balance will continue to be tight, most of the increase in material resources will be provided by increasingly difficult and demanding imports, and meeting the requirements of the economy and the populace and the process of socialist economic integration will increase the demand for rapid development of basic sectors and a change in the structure of production.

Accordingly, the basic aim of our economy during the Seventh Five-Year Plan will be to increase national economic efficiency by intensification. The means of achieving this goal in a developed socialist society is development and improvement of the system of management of the national economy.

The use of data-processing equipment and its advanced form, AMS, is an important rationalization and innovation tool for development of the system of planned management of the national economy. A condition for the effectiveness of this tool is that automation penetrate into all areas of management and that the creation of AMS be consistently interconnected with all aspects and all measures in the development of the planned management system. Accordingly AMS development must be oriented toward areas in which a direct effect can be achieved and which play an essential role in the system of planned management of the national economy. In keeping with CSSR Government Decree No 42/1980, the following should be considered the decisive directions in the introduction of data-processing equipment during the Seventh Five-Year Plan:

--the construction of an automated system for planning calculations in conjunction with measures to improve the effectiveness of national economic planning;

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--comprehensive introduction of automated management of supplier-purchaser relationships so as to increase the effectiveness of accounting and to make possible monitoring of commercial contracts and of supply;

--the use of automated information systems for gradual evaluation and monitoring of the effectiveness of the reproduction process as a whole.

In other areas, when developing AMS it is necessary to focus on:

--consistent monitoring of the connection between enterprise AMS and automated systems for control of manufacturing processes;

--the development of uniform organization data bases and the creation and use of standardized regional planning activities which will make it possible to integrate the various AMS levels.

To achieve these ends, it will also be necessary to strengthen the procedural and coordination functions of AMS in bodies with a regional planning function and to see that they are interconnected with the AMS of other bodies. This will be the basis for gradual vertical and horizontal interconnection of AMS.

At the VHJ level, it will be necessary to organize AMS for the management of technical and economic planning, plan monitoring and implementation, the management of capital construction and sales, the management of distribution and cooperative relationships, and management of the development of subdivisions and products.

At the production enterprise level, during the Seventh Five-Year Plan it will be necessary to give priority to arranging automation of manufacturing processes, technical preparation for production and running management of production, material and technical supply and sales, labor and wages.

In other enterprises and organizations, the development of AMS will be oriented toward the critical areas of activity in accordance with the purposes of the ministries.

Data-processing equipment is also being used in the entire scientific and technical development system and in associated investment activities. It will be used both in the management of these activities and directly in the performance of research tasks and design work and in the creation of data banks on the territory of the CSSR, among other things. The use of computers for scientific and technical computation is of great help in making the intellectual work of scientific workers more efficient. The automation of design and planning work makes it possible to work out alternative designs and select the optimal alternatives, while requiring a smaller number of workers to do routine work. We must not omit the fact that these types of optimization will lead to investment savings. Automated planning using data banks on the various territories and the creation of an automated construction project register will give effective help in decreasing investment costs in the national economy.

A critical area of the use of data-processing equipment will be automated systems to control production and manufacturing processes. Automated process control will

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have a decisive role in achieving the necessary savings of energy, raw materials, other materials and labor, will substantially increase the utility value of automatic control systems and will also have a positive effect in improving the quality of the working and living environment.

Automation will also be used in conventional processes in metallurgy, machine building, the chemical industry and building materials production, where its effectiveness has already been demonstrated in a number of cases. For example, automatic control of blast furnace operation is yielding a considerable saving of coke and improving blast furnace productivity and uniformity of operation.

Data-processing equipment will also be used to control manufacturing processes in other sectors such as agriculture, the food industry, commerce and the services. It will also establish itself solidly in health services. As an important example from this area, we may mention the use of computers to manage a large-scale food warehouse in Ruzyne which supplies the commercial network for almost half of Prague. If this computer had not been installed, it would not be possible to utilize fully the capacities of this warehouse, which represents a large investment.

The result of this basic orientation of AMS during the Seventh Five-Year Plan will be in particular that the use of automation in the management activities of all offices with a regional planning function will impose more stringent demands regarding their form and their procedural influence on other management offices and their AMS. The necessity of assigning high priority to creating AMS in these organizations stems from their importance for all management of the national economy. Concentration of effort on the creation of AMS for the regional planning organs will make it possible to create the preconditions for their exertion of a procedural influence in an extensively automated environment, and thus for an interconnection of decisionmaking processes within the regional planning organizations with management processes along the vertical axis of sectorial management. This will mean further improvement of efficiency, particularly through simplification and stabilization of directions and instructions.

Achievement of the goals of the AMS development may be effectively furthered by strengthening and improving the existing method of managing their development and by the introduction of data-processing equipment. Improvement is needed at all management levels, focused on their areas of responsibility and in keeping with the principles of improving the system of planned management of the national economy.

Procedural and standards support for development of AMS will continue during the Seventh Five-Year Plan to be a tool for rationalizing, simplifying and improving the effectiveness of AMS development.

The provision of methodology for the specific content of AMS comes under the purview of the relevant regional development and sectorial offices and requires that these offices design the methodological instructions, directives and regulations by which they manage their activity in the assigned area so that they are in keeping with possibilities for automation. This particularly involves

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adapting documents, forms, directions and procedural instructions to the principles of automation. At the same time, procedural work must be stepped up, particularly as regards numeration, listings and classifiers.

The provision of procedures and standards for the design of AMS will be based on publications of the Federal Ministry of Technical and Investment Development concerning the development and documentation of AMS.

One of the critical factors in AMS development is data-processing equipment, including systems for preparation, collection, preprocessing of data, and communications channels. The provision and utilization of this equipment must be based on:

--consistent utilization of JSEP and SMEP (System of Small Electronic Computers) machines, which are the basic hardware for AMS and whose advanced capabilities will make it possible to increase existing data-processing equipment capacities in the national economy;

--more intensive utilization of computers (by operating more shifts, decreasing installation and running-in time, and more demanding utilization of computers) which is the basic precondition for fulfillment of the guidelines which have been laid out for development of AMS within the existing capabilities of the national economy;

--stressing the contributions of minicomputers and microcomputers in AMS construction;

Third-generation JSEP computers will become available during the first years of the Seventh Five-Year Plan, and 3.5th-generation computers later. These computers will constitute a decisive majority in the organizations' AMS base. Computers of the the 3.5th generation will have greater speed, larger memory capacity, better reliability, easier maintainability, plus data bank, virtual memory and remote processing capabilities.

The corresponding 3.5th-generation peripherals will become available at the same time. In this area, there will be a gradual movement away from classical methods of data acquisition and output (punched cards, punched tape and printers) to more modern methods (direct recording on magnetic disk and tape, optical character reading). In addition, it is expected that the comprehensive data preparation, collection and preprocessing systems which are essential for utilization of the great power of 3.5th-generation computers will be introduced.

In the Seventh Five-Year Plan, data-processing equipment will undergo a fundamental expansion to include minicomputers and microcomputers, represented by the SMEP series. Because of their low cost and adaptability, these computers will be used in a range of applications from the handling of office paperwork and preprocessing of data for larger computers, through control of manufacturing processes, to use in the AMS of small organizations. The past shortage of control computers will be resolved in the Seventh Five-Year Plan by the introduction of

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SMEP computers. These minicomputers and microcomputers will be introduced into the material production area in automated systems for control of manufacturing processes, especially processes in the metallurgical, machine building, power production and chemical industries. The development of ASRTP [automated systems for control of manufacturing processes] requires that high-quality, reliable automation components (regulators, sensors and the like) be produced.

In the Seventh Five-Year Plan it will be necessary to devote more concentrated attention to the utilization of computers and to the introduction of other efficiency-improvement measures which will substantially increase the overall capacity of data-processing equipment installed in the national economy. This will entail:

--improving preparations for introduction of computers so as to decrease substantially the time required to put a computer into operation, and during the second year after it is put into operation, to use it in two shifts, each of which includes 75 percent productive work;

--taking a more consistent approach to the creation of cooperative computer centers so as to develop a larger number of multiuser AMS with a smaller number of computers;

--creating ministerial networks of computer centers, whose computer capacities are currently more fully utilized than those in individual computer centers;

--progress in developing a territorial network of computer centers;

--use of the technical capabilities of the latest-generation computers, particularly time sharing, so as to achieve a time-sharing coefficient greater than 2 during the Seventh Five-Year Plan.

Another decisive factor in developing AMS during the Seventh Five-Year Plan is provision of effective basic software, standard programs for data manipulation and applications programs. The trend away from individual solutions in favor of standardized multiple-use solutions will come increasingly to the fore in the development of applications programs. This tendency will lead to more effective, higher-quality, faster creation and utilization of applications programs. The Set of Measures for Implementation of Standard Automated Management System Software, developed on the basis of CSSR Government Presidium Decree No 01/77, will be gradually put into operation. The development of joint applications programs will be developed by a sectorial-leading AMS organization and a selected design organization. This approach will improve relations between the developers and users of standard applications programs and will create the conditions for speeding up the research-development-production-use cycle in the AMS field.

In the future, AMS development will require that attention also be devoted to personnel training both in AMS development and in the user organizations.

In both areas attention will be devoted to training management personnel in accordance with the effects of automation on management methods and style. In

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training user organization staff it will be necessary to stress the effectiveness of preplanning preparation for AMS, particularly in formulating the organization's requirements for the designer.

The main task of those engaged in research is to solve sufficiently in advance the problems which are critical for effective development of automated management. These are primarily questions in the development of AMS theory, questions of the creation and development of the AMS as a whole, and questions regarding its scope and its economic, social, organizational-legal, software-hardware and personnel aspects. Also involved is a search for progressive ways of constructing and developing AMS efficiently.

A considerable part of this problem is of an interdisciplinary nature and necessitates cooperation between experts in a number of scientific fields and specialties. Problems must be solved in basic, economic and applications research, bearing on development and planning. Even if some of the research results affect AMS development in this five-year plan, the decisive effect will occur in the subsequent five-year plan.

Research problems during the Seventh Five-Year Plan are concentrated on the following basic areas:

--theoretical questions of management in an automated environment;
--conceptual and system-level problems of AMS;
--procedural problems of AMS development;
--AMS hardware and software;
--AMS data support;
--organizational-legal support of AMS;
--the creation of whole complexes for multiple use.

Satisfaction of these basic prerequisites in the areas critical to AMS development can create the basic conditions for fulfillment during the Seventh Five-Year Plan of the basic aims of AMS development in the national economy as a whole and in the individual sectors, and can thus lead to implementation of the Set of Measures for Improving the System of Planned Management of the National Economy.

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